

[0017] FIG. 4B is a cross sectional view of components used to form the multi-component module of FIG. 1 after a third stage of manufacture, according to an illustrative embodiment of the invention.

[0018] FIG. 5A is a cross sectional view of components used to form the multi-component module of FIG. 1 after a fourth stage of manufacture, according to an illustrative embodiment of the invention.

[0019] FIG. 5B is a cross sectional view of components used to form the multi-component module of FIG. 1 after a fifth stage of manufacture, according to an illustrative embodiment of the invention.

[0020] FIG. 6 is a cross sectional view of components used to form the multi-component module of FIG. 1 after a sixth stage of manufacture, according to an illustrative embodiment of the invention.

[0021] FIG. 7 is a cross sectional view of components used to form the multi-component module of FIG. 1 after a seventh stage of manufacture, according to an illustrative embodiment of the invention.

[0022] FIG. 8 is a cross sectional view of components used to form the multi-component module of FIG. 1 after an eighth stage of manufacture, according to an illustrative embodiment of the invention.

[0023] FIG. 9 is a cross sectional view of components used to form the multi-component module of FIG. 1 after a ninth stage of manufacture, according to an illustrative embodiment of the invention.

[0024] FIG. 10 is a cross sectional view of components used to form the multi-component module of FIG. 1 after a tenth stage of manufacture, according to an illustrative embodiment of the invention.

[0025] FIG. 11 is a cross sectional view of the multi-component module of FIG. 1 after an eleventh stage of manufacture, according to an illustrative embodiment of the invention.

[0026] FIG. 12 shows layered multi-component device 1100 according to an alternative illustrative embodiment of the invention.

[0027] FIG. 13 shows a close-up view of the device 1100 of FIG. 12.

[0028] FIG. 14 shows a flow diagram depicting a method 1300 of fabricating the device of FIG. 12, according to an illustrative embodiment of the invention.

[0029] FIG. 15 shows a close-up view a second portion of the device 1100 of FIG. 12, and in particular shows microfluidic features for heat dissipation and for environmental sampling according to an illustrative embodiment of the invention.

[0030] FIG. 16 shows a close-up view of a third portion of the device 1100 of FIG. 12 and shows an element for routing optical signals, according to an illustrative embodiment of the invention.

DESCRIPTION OF CERTAIN ILLUSTRATIVE EMBODIMENTS

[0031] The invention, in various embodiments, provides devices and methods for multi-component modules and/or methods of manufacturing multi-component modules. The following detailed description of the invention refers to the accompanying drawings.

[0032] FIG. 1 is a cross sectional view of a multi-component module according to an illustrative embodiment of the

invention. The device 100 has two layers 110 and 112. The two layers 110 and 112 are bonded together to form the device 100.

[0033] Layer 110 has five modules 114, 116, 118, 120, and 122. In the illustrative embodiment, modules 114, 116, 118, 120, and 122 are dies. The dies 114, 116, 118, 120, and 122 are encapsulated by an encapsulating polymer 199. The dies 114, 116, 118, 120, and 122 feature metal contacts 124, 126, 128, 130, 132, 134, 168, 138, 140, and 142. The metal contacts 124, 126, 128, 130, 132, 134, 168, 138, 140, and 142 are interconnected with metal contacts on other modules, as required. In the illustrative embodiment, metal contact 128 is interconnected to metal contact 140 by means of interconnect 150 and vias 152 and 154.

[0034] Modules are also interconnected between layers, as required, using metal or metal-coated posts 180, 182, 184, 186, 188, and 189. In the illustrative embodiment, metal contact 170 of die 160 on layer 112 is interconnected with post 180 by interconnect 190. Post 180 is further interconnected with metal contact 124 of die 114 on layer 110 by interconnect 192.

[0035] In the illustrative embodiment, layers 110 and 112 are identical. In other embodiments, the modules may have different lengths, widths, and thicknesses. The modules may include integrated circuits, semiconductor dies, microfluidics, optical components. The modules may also be fabricated in different technology types. For example, a multi-component module may include an RF module fabricated in GaAs and a digital signal processor module fabricated in Si.

[0036] In other embodiments, the device may include only one layer. In other embodiments, the device may include more than two layers. The invention does not limit the number of layers a manufacturer may include in a device.

[0037] FIG. 2 is a cross sectional view of components used to form the multi-component module of FIG. 1 at a first stage of manufacture, according to an illustrative embodiment of the invention. A manufacturer generally begins the process of manufacturing a multi-component module with a silicon wafer 102 and a temporary carrier 104 with a sticky surface 106.

[0038] FIG. 3 is a cross sectional view of components used to form the multi-component module of FIG. 1 after a first stage of manufacture, according to an illustrative embodiment of the invention. Referring to FIGS. 2 and 3, in the first stage of manufacturing, the manufacturer etches the wafer 102, resulting in wafer 201. The etching process forms posts 202, 203, 204, 206, 208, and 209. The manufacturer may optionally etch die plinths 210 and 212 if the dies to be packaged in a subsequent step on wafer 201 are of non-uniform thickness.

[0039] The manufacturer then positions dies 218, 220, 222, 224, and 226 face down such that the electrical contacts 228, 230, 232, 234, 236, 238, 240, 242, 244, and 246 make adhere to the sticky surface 106 of the temporary carrier 104. In certain embodiments, dies 218, 220, 222, 224, and 226 have non-uniform dimensions.

[0040] In one embodiment, the posts 202, 203, 204, 206, 208, and 209 of the wafer 201 may have a very high aspect ratio. In a certain embodiment, very high aspect ratio posts may be formed by depositing metal into a polymer mold deposited on the surface of the wafer.

[0041] In another embodiment, the posts 202, 203, 204, 206, 208, and 209 of the wafer 201 may have a low aspect